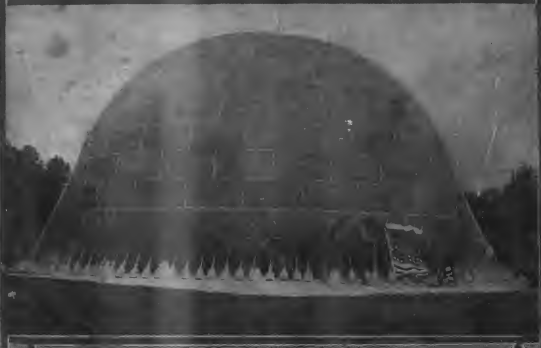


FEBRUARY 1, 1909

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VOLUME VI  
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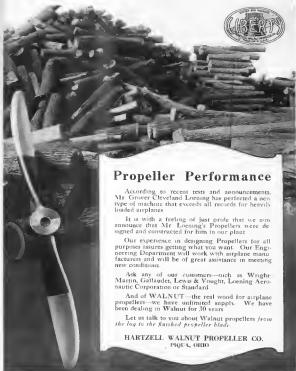
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FEBRUARY 1, 1919

# AVIATION AND AERONAUTICAL ENGINEERING

VOL. VI. NO. 1

Member of the Audit Bureau of Circulations  
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THE GARDNER - MOFFAT COMPANY, Inc., Publishers  
HARTFORD BUILDING UNION SQUARE, 12 EAST SEVENTEENTH STREET, NEW YORK  
WASHINGTON OFFICE, OPPOSITE THE BUILDING

SUBSCRIPTION PRICE, THREE DOLLARS FOR YEAR, SINGLE COPIES TWENTY-FIVE CENTS. CANADA, THREE AND A HALF DOLLARS. FOREIGN, FOUR DOLLARS A YEAR. COPYRIGHT 1919 BY THE GARDNER-MOFFAT COMPANY, INC.

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# AVIATION AND AERONAUTICAL ENGINEERING

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TECHNICAL EDITOR  
LAFRANKE STONEY  
ASSISTANT MANAGER  
GEORGE NEWBOLD  
BUSINESS MANAGER

Vol. VI

February 1, 1919

No. 1

THESE are printed in the present issue excerpts from technical reports submitted by special sub-committees to the British Committee on Civil Aerial Transport, to which particular attention is invited. These reports possess considerable value as illustrating some of the complex questions that arise in connection with the establishment of commercial aviation, the more so as they represent the opinions of a large number of authoritative men possessing scientific, technical, manufacturing, and practical experience in aeronautics.

It is interesting to note the emphasis which is placed in the British report upon the commercial future of the airship, particularly as a long distance carrier of passengers, goods, and mails. This subject is treated very comprehensively by Wing Captain Marshall R.N.—one of the earliest British airship pioneers—in a report which is printed in this issue, in extenso.

This report as well as sundry information that has recently reached this country from abroad bear out the fact that Great Britain fully grasps the great possibilities the airship presents for heavy weight transportation at a high rate of speed over distances exceeding 1,000 miles at a stretch. Thus it is suggested that nine airship stations and a number of naval air ships will shortly be made available for civilian use by the British Admiralty. This is a preliminary step forward, and a similar action with respect to the establishment of British commercial airship services cannot be doubted for a moment, particularly in view of the fact that Great Britain has, unlike her Allies, not only possessed Germany's Zeppelins as trophies in short, but has, on the contrary, recognized her own shortcomings in this craft in connection with naval warfare, and has since the war expended considerable efforts for overcoming Germany's lead in this field. That these endeavors have been crowned with success is proven in the performances of the most recent British naval air ships of rigid type, which have a running endurance of over 200 hours. The possibilities such a craft holds forth for commercial purposes are obvious.

Germany, of course, has for the last twenty years been the undisputed champion of the airship, and has persisted in this attitude entirely regardless of most stupendous failures, all of which have by the way advanced the science of airship construction. The latest developments in this field—in particular the successful production of a semi-rigidly lifting gas, helium, by American chemists—show that Germany has not an iota of a right to maintain her faith in the airship and especially in the rigid type.

The performances of passenger Zeppelins have which

were operating between various German cities from 1910 to 1914 gave the first indication of the commercial possibilities of the rigid airship. It is true that these services were heavily subsidized by the German Government, which had an obvious interest in developing this type of aircraft, but even so the proof of these services was reasonable and convincing in that the Zeppelin passenger never lost his life in a trip, although several of the airships were lost owing to various causes.

Little surprise is therefore caused by press reports announcing that the Zeppelins works at Staaken are engaged in building a commercial airship destined for trans-Atlantic service which will have accommodation for 100 passengers and 45 tons of mail and baggage. It is planned to build a fleet of twelve ships of this type, of which eight will be for actual service, while four will be kept in reserve. While these plans are actually conditional upon the peace terms that will be imposed upon Germany, they nevertheless give a remarkable indication of how even a defeated nation can work for the future of commercial aeronautics.

Now it seems that if a defeated Germany can entertain such ambitious plans for capturing the world's coming air-borne trade, the United States, which has come out victorious of the great World War, should at least contribute its share to the creation of rigid transportation services before the war of aerobics.

Of course, the difficulties which will have to be overcome in this country in an endeavor to create a satisfactory type of rigid airship should by no means be undervalued. Germany has an advance of some fifteen years in this field over the rest of the world, with the sole exception of Great Britain, which comes a close second owing to the extraordinary efforts she has made during the war to make up in the shortest possible time for past errors. Thus there are today two countries which possess types of airships which are entirely adequate for navigating regular passenger services over long distances—Great Britain and Germany.

Neither France nor Italy, nor the United States have any type of airship that could successfully compete with the large rigid vessels of the British and the Germans.

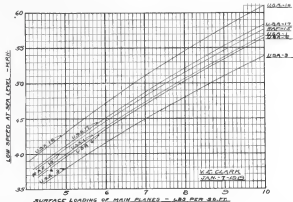
In view of the geographical position and topography of this country as well as of its legitimate interests in South America and the Pacific it is urgent that steps be taken at once in order to meet—directly and by, with Government assistance—an American commercial airship fleet. In this matter time is precious, for every day lost increases the superiority the foreign airship fleets will possess in carrying the air-borne trade from east to these shores and make our efforts at overcoming our shortcomings proportionately more difficult.

# Selecting Aerofoil Sections for Speed Range

By Lieut.-Col. V. E. Clark, A. S.

The accompanying charts were developed to serve as a "rough and ready" means of choosing the best aerofoil section for speed range. Incidentally, the charts serve to roughly estimate the speed performance to be expected in a given airplane.

In plotting these charts it has been assumed always that the airplane is a single-engine, biplane tractor of good form.



dynamic design, with full rubber equipment installed. The best values of air density, horsepower and air speeds are assumed throughout.

In Fig. 2 the three curves (I) calculate the air speed range to be expected for various values of power loading and surface loading. That is, they are meant to show the speed range (high speed in percentage of low speed) plotted against values of low speed in ft.

Curve (II) represents the value of air speed required for maintenance in percentages of maximum air speed, plotted against percentages of maximum value of lift coefficient,  $K_L$ . Because of the form of the equation

$$\text{Weight} = \text{Lift} = K_L V^2$$

( $K_L$  for air lift density),

this curve is a parabola, with its asymptote at the minimum air speed zero percentage of maximum  $K_L$ .

Curves (III) represent values of  $K_L/K_0$  or  $L/D$  for air loads available, plotted against percentage of maximum  $K_L$ . The values in these curves have been corrected, as accurately as possible,

for the full scale and speed, biplane with 17 per cent stagger, gap, chord ratio 1.69 (for which biplane configuration considerable experimental data is available), aspect ratio 7, rounded wing tips, etc. The angles of incidence indicated by points along the curves are those above the angle of zero lift.

On the chart Fig. 1 are plotted curves for the same aerodynamic data, but for the same area, of the maximum speed at sea level (in miles) to be expected.

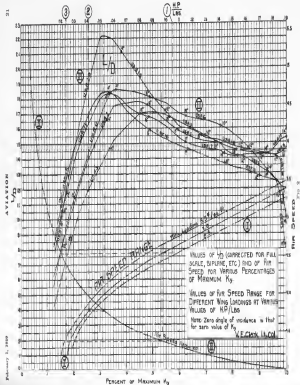
Figure 1 is a graph showing the low speed at sea level (in miles per hour) versus the surface loadings of the main planes, in pounds per square foot. These curves have been corrected for full scale and speed, biplane (as described in this chart, etc.).

## Method of Using Charts

Suppose we have to find the design, or are presented with a design in which an engine with a given hp is contemplated, the total weight of the airplane is fixed, and the total area of the main wing surfaces.

Figure 1 is, 2 is, the top bar for the value of hp, weight in lb. Drop vertically until we intersect Curve (I) for the value of the wing loading in lb. per sq. ft. Interpolation or estimation is usually necessary. Then horizontally across until we intersect Curve (II), then vertically, until we intersect the L/D curve. The parallel which gives the best value of L/D in this region is evidently the aerodynamic section which will give the maximum speed range for the airplane with the characteristics assumed.

Example 1—Suppose we have a single-engine, tractor bi-



February 1, 1928

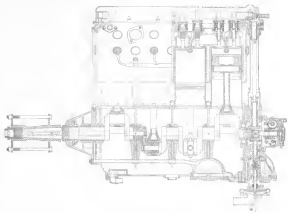


and valves are actuated by an overhead camshaft and operate in a perfectly balanced manner.

At the end of the cylinder block there is a vertical shaft which drives the camshaft through bevel gearing. This is called the upper vertical shaft and has a corresponding gear above the level of the crankcase so that it forms a unit with the cylinder assembly. These cylinders, valves, camshaft and crankshaft drive form a complete unit which is both light and compact.

#### Crankcase

Owing to the nature of the cylinder assemblies the crankcase is comparatively simple. There are upper and lower halves.



Diagrammatic Cross-Section, Side View

splitted on the center line of the crankshaft, and the respective halves of the bearings are carried directly in the crankcase halves. The upper and lower crankcase halves are bolted together very strongly and, since each half takes its share in supporting the crankshaft, the case as a whole is very rigid and light in weight.

Each half has an aluminum casting and the upper half has a projecting foot running the entire length of the case on each side forming the footplate from which the engine is supported.

In the upper half, at the rear end, there are two short shafts to bronze carriers, called the lower vertical shafts. Each of these shafts has a bevel gear at the lower end and meshing with a bevel gear on the crankshaft. The upper ends of these two shafts project above the crankcase and are attached to rotate the linkages on the ends of the upper vertical shafts which are attached to the cylinder blocks as described. It is thus possible to remove and replace cylinders without disturbing any of the crankshaft drive gearing.

The lower half of the crankcase supports another shaft with a bevel pinion at its upper end, the pinion meshing with the same gear on the crankshaft which drives the camshaft. This shaft is vertical and mounted in a bronze carrier rotating upon a hole in the aluminum of the case. The lower end of this shaft carries a small spur gear, by which the oil pump is driven, and beneath this spur gear is a linkage which provides the drive for the water pump in a manner which will be described later. Thus one bevel gear on the crankshaft drives the two camshafts, the oil pump and the water pump. This completes all the gearing on the engine except the magnets drive. It should be noted that the vertical shafts between the

case, and this bracket carries a spiral gear. The upper member of this gear has a short intermediate shaft on each end of which the magnets couplings are mounted, and the runs in ball bearings located in the aluminum of the bracket. The couplings, then, as they allow for sufficient universal motion. The lower of the gear of spiral gear has a shaft of which one end is set in a ball bearing in the bracket while the other end has a bronze which engages with the slot in the end of the crankshaft.

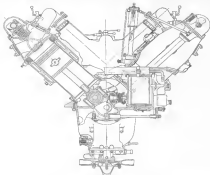
This design enables the magnets to be detached readily, since they are driven by couplings of an easily detachable nature. It should also be noted that the magnets are at-

tracted by four bolts, thus making them as quickly known as the "screw type" of rot.

The block of the bronze has between the feet of the forked end is turned and forms the bearing for the other crankshaft end, which is fitted to it in the conventional way. This construction makes it very easy to replace connecting rod bearings since the oil bronze has to be removed and a new one substituted very quickly.

#### Lubrication System

There is one main oil channel, this being a steel tube cast in the lower half of the crankcase, in which the oil pump is located as already described. From this main channel oil



Diagrammatic Cross-Section, End View

traced for right hand and the other for left hand rotation, so they face apart, but are driven by one shaft.

#### Pistons

The pistons are aluminum alloy of very simple design with a head 15 in. thick, the side walls tapering from the thickness down to 4 in. The purpose of a very thick head is to carry very light as rapidly as possible from the center of the piston and to distribute it in the walls, where it is carried off through the cylinder. There are three piston rings placed close together and one oil scraper ring at the bottom, the piston being relieved below this.

The piston pins first, that is, they are free to turn in the connecting rods or in the pistons. To prevent angular movement of the pins, there is an aluminum plug which closes the outer end of the hole in each piston boss. This plug has linkages which engage slots cut in the piston and therefore cannot turn. This construction as shown very clearly in the plate.

#### Connecting Rods

There are two types of connecting rod used in each engine. One is forged and laminated in two flat feet, while the other is split and provided with a cap. The forked end has attached to its feet a split bronze bar fixed with ball bearings which bears upon the crankshaft. The connecting rod is attached to the

piston to the four main bearings of the crankshaft. Each of the main bearing brackets is rigidly secured by a gasket cast in the aluminum which is thus kept full of oil. Flushing through holes in the bearing oil reaches the crankshaft and passes on through holes in the shaft completely like the oil passing on through holes in the shaft through other holes which lead to the lower side of the connecting rods. Further to be in the main connecting rod member lead the oil to the water and bearing. Piston and wrist pin lubrication is performed by the oil which reaches from all bearings.

Crankshaft and valve lubrication is obtained by taking oil from the grooves around the front and main bearing and leading it up through two small steel pipes, one attached to each cylinder block. These lead to holes in the aluminum, registering with holes in the front and crankshaft bearings. Thence the oil enters the crankshaft, casing, which is hollow from end to end, and small holes drilled in each case allow lubricant to be discharged directly upon the pistons. These holes are on the opposite face of the case and so oil the tappet and rest on the case begins to lift. The system not only lubricates the valves themselves but flows into the bearing supporting the upper vertical shaft. Here it obtains access to the space within the tube enclosing the vertical shaft, falls down the shaft lubricates the lower vertical shaft bearings and returns to the crankcase through the hole drilled right through the lower vertical shaft. Every bearing and gear in this takes care of in proportion to its requirements.



## The Naval Aircraft Factory

On July 27, 1917, Secretary of the Navy Daniels signed the document which authorized the only government-owned and -operated factory this country has ever possessed, the Naval Aircraft Factory. Fourteen days later construction work actual-

at a faster rate than they could be provided by building as entirely independent factory, the reformer provided that the new structure should be an assembly plant, where bulk, wings, and other parts, placed under contract, with private manu-



FIG. 1. AERIAL VIEW OF THE NAVAL AIRCRAFT FACTORY.

by Rogers at the League Island Navy Yard, Philadelphia, as a site selected by Standard Construction Co. of Chicago, U. S. N. who had been appointed manager of the factory. From the day the first spade struck the level bit of ground upon which the plant was to be erected the work proceeded with unexampled celerity. On Oct. 18, 1917, the first machinery started in motion; three weeks later the keel for the first flying boat was laid, and on March, 1918, the first service machine produced by the factory made its trial flight.

### Site and Dimensions

The original manufacturing shed, with a ground area of 100,000 sq. ft., is a permanent steel structure, which was built and equipped in about three months' time at a cost of about \$1,000,000. Early in January the Navy's aircraft program was very largely expanded and this necessitated an enlargement of the factory, comprising five buildings with a floor area five times that of the original plant. As the expanded program required aircraft



FIG. 2. VIEW OF THE FINAL ASSEMBLY PLANT.

workers, would be needed. The new plant was designed with generous dimensions so as to admit for future increase in size of aircraft, and was laid out for multifarious use, not up to date 1917's, permitting future liberty the features of progressive assembly.

The buildings of the Naval Aircraft Factory now extend over 60 acres of ground along the Delaware, the huge assembly plant, which may be seen in Fig. 3, at the right hand side, alone has a floor area of 3,500 ft. The manufacturing plant (visible at the extreme left in Fig. 3) comprises a large woodworking division & complete metal shop and a benching plant.

On the day the structure was signed the factory employed 3,800 workers, half men-quarter of them being women; over 5,000 men and women were employed on work estimated for by privately owned firms. The production was at that date one three-engine flying boat per week, but previous work made for virtually doubling this output, should the need arise.

### Internal Organization

The putting in operation of the huge plant in record time entailed an achievement which is in the highest credit of Navy methods as well as to the executive ability of Naval Constructor Colburn, manager of the factory. This is amply indicated by the fact that of the 3,800 workers employed only twenty-five have had previous experience in aircraft work.



FIG. 3. THE NAVAL FLYING BOAT F-5-L.

At the time the factory began operations, experienced aircraft workers had all found a berth in the industry, while regular Navy officers capable of acting in executive positions, in connection with aircraft work were few in number, and generally engaged on other duties. The need for an executive force and a technical staff was filled by selecting from civil life men particularly adapted to the work as an undertaking, and it is noteworthy in view of the contention that so few of the principal department heads came from the same line of industry. The problem of supplying man-power fell upon

regulation of materials, manner of control in all factory departments and the scheduling of work and equipment.

The Supply Department receives the rapid transportation of the finished aircraft to their destination.

The Contract Manufacturing Department is responsible for maintaining the output of the assembly plant at its highest capacity by supplying the component parts of the finished product for final assembly. For the manufacture of bulk the yards of many former plant builders were utilized, for wing panels several large woodworking establishments, for metal parts and large machine industries were called upon, among others a brass-plate plant. At all of these places branch offices were created for the directing of production, for inspec-



FIG. 4. INTERIOR OF THE PILOT AND RADIO COMPARTMENTS OF AN F-5-L.

the Employment Division, the need of good methods, including those provided by the Government, and did not stop at receiving talent, but also developed it. The this program an apprentice school was organized, in which, women, with no previous training, and selected only by patriotism, were instructed in factory rules and methods. This method has given very satisfactory results.

The Engineering Department covers the designing of all mechanical and production machines, and the inspection and testing of material, work in progress and the completed pro-



FIG. 5. A BOAT IN ITS CARRIER ON AN F-5-L.

duce, and for industrial protection, by the agency of a technical personnel supplied by the Naval Aircraft Factory.

The spirit which permeates the whole establishment, from the executive down to the smallest shop hand, was aptly expressed by the Manager's own words in an address delivered to the employees: "Let us make our product so well and so fast that the only person the public will have for aeroplanes is us in fact and law in the future—'we do it'." And it is indeed a matter of record that while the progress of the Navy aircraft program was phenomenal, in a remarkable series of errors and failures, which involved the wastage of huge sums, the work of the Naval Aircraft Factory has proceeded throughout the war with a strict efficiency that thoroughly fulfilled the expectations placed upon it.

### The Naval Flying Boat

As the more progressive, the Naval Aircraft Factory was originally designed to fit all the requirements of the Navy, which means that it was essentially to produce lighter than air as well as heavier-than-air craft. However, since the stress of war is on expanded naval operations and to maintain the time being the construction of lighter-than-air craft, which has and will grow steadily been a subject of considerable interest.



Fig. 1. The S. S. S. S. S. S.

in this country. Therefore, considering the construction of a large carrier, the work of the Naval Aircraft Factory, during the war, is entirely devoted to producing a type of airplane which was designed to carry, under the most severe conditions, the heaviest amount of the equipment, in carrying ships through dangerous seas, making the shore land and attacking submarines with their depth charges.

The modified, large patrol craft developed for this purpose, the P-4, is a flying boat of 185 ft span, 50 ft length and 11 ft 6 in. high, with a 110 ft wing span. The P-4 is a flying boat of 400 hp, with a 110 ft wing span, 50 ft length and 11 ft 6 in. high, with a 110 ft wing span. The P-4 is a flying boat of 400 hp, with a 110 ft wing span, 50 ft length and 11 ft 6 in. high, with a 110 ft wing span.

Commercially, the machine follows the best modern practice of airplane design. The hull is built of aluminum and is covered with a double plating of steel. The hull is covered with a double plating of steel. The hull is covered with a double plating of steel. The hull is covered with a double plating of steel. The hull is covered with a double plating of steel.

## The Miller 125 Hp. Aircraft Engine

This engine, which is manufactured by the Miller Aircraft Co. of Los Angeles, Calif., is a vertical type, with four cylinders in line. The cylinder has a bore of 4 in. and a stroke of 7 in., giving 52 cc. displacement. At 1,800 r.p.m. the engine has a normal output of 125 hp. Its power output can be raised to 130 hp at 2,000 r.p.m., and 150 hp at 2,500 r.p.m. As it is not desirable, for reasons of safety and efficiency, to run an aircraft at such high rotational speeds, the Miller engine is fitted with a reduction gear, which has a ratio of 2 to 1, so that the speed of the propeller is reduced to from 1,500 to 1,400 r.p.m. The reduction gear has a diameter of 8 in. and a pitch of 1.5 in.

A noteworthy feature of this engine is that all its parts are interchangeable.

### Wear Factors and Conditions

The wear factors and the conditions of the barrel type—its cast integral of aluminum, a special alloy developed by the firm. Piston and connecting rods may be easily removed for inspection through side plates, without need for the engine from its bed.

weight is fitted a spacious pilot compartment, seating two men side by side. Behind the pilot, and under the seat, is the radio installation, to which an antenna is fed through a cable. The wing and tail units are built up of ash and spruce ribs with a cardboard sheath.



Fig. 2. The Miller 125 Hp. Aircraft Engine, with a 110 ft wing span.

Six thousand cubic ft. of air is drawn into the engine at 1,800 r.p.m. and is fed to the cylinders through 100,000 sq. in. of area, and 40,000 sq. in. of area. The 110 ft wing span, 50 ft length and 11 ft 6 in. high, with a 110 ft wing span. The P-4 is a flying boat of 400 hp, with a 110 ft wing span, 50 ft length and 11 ft 6 in. high, with a 110 ft wing span.

During these long patrol runs, which have constituted the greater part of the Naval Aircraft Factory, various types of equipment, designed for long periods of time, have been built for commercial purposes. One of these is the P-4, a flying boat of 400 hp, with a 110 ft wing span, 50 ft length and 11 ft 6 in. high, with a 110 ft wing span.

The P-4 is a flying boat of 400 hp, with a 110 ft wing span, 50 ft length and 11 ft 6 in. high, with a 110 ft wing span. The P-4 is a flying boat of 400 hp, with a 110 ft wing span, 50 ft length and 11 ft 6 in. high, with a 110 ft wing span.

### Cylinder Heads

The cylinder heads are cast aluminum. Four and one-half inches wide for each cylinder and are integrated with the head. The head is built up of ash and spruce ribs with a cardboard sheath.

### Valves

The valves are driven out of aluminum, are completely machined. The valves are cast into the water jacket, and are packed with rubber ring seals. The cylinder head has a 110 ft wing span, 50 ft length and 11 ft 6 in. high, with a 110 ft wing span.

### Construction

The construction is cast aluminum and constructed of two parts, one together at the center with a 110 ft wing span, 50 ft length and 11 ft 6 in. high, with a 110 ft wing span.

### Connecting Rods

The connecting rods are tapered and slightly tapered. The connecting rods are tapered and slightly tapered. The connecting rods are tapered and slightly tapered.

### Wash Gear

The wash gear is built up of four cast iron parts, and five gear for the hull bearings, mounted on a tubular shaft. A cast iron

improves an ash tank and its followers, and an exhaust can and its followers. The exhaust can carries the exhaust to the main tank, giving a positive suction to the engine. The ash tank is heated and has a built-in oil.

The ash tank is heated and has a built-in oil. The ash tank is heated and has a built-in oil. The ash tank is heated and has a built-in oil.



Fig. 3. The Miller 125 Hp. Aircraft Engine, with a 110 ft wing span.

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## Commercial Transport by Airplane\*

In considering the possibilities of the employment of air and the purpose of the transport of passengers, mail and goods, the National Bureau of Standards has made a study of the following factors, which are of importance in the design of an airplane, and the following factors, which are of importance in the design of an airplane.

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(9) The National Bureau of Standards has made a study of the following factors, which are of importance in the design of an airplane, and the following factors, which are of importance in the design of an airplane.

the engine and deliver it to the supply tank. All oil passages are cast integral with the engine. Connecting rods are cast with side plates. All oil passages are cast integral with the engine.

### Reduction Gear

The reduction gear is of the planetary type. The three planet gears are mounted in a cast housing with the propeller shaft. The propeller shaft is at a center line with the

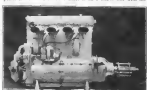


Fig. 4. The Miller 125 Hp. Aircraft Engine, with a 110 ft wing span.

reduction gear. All air passages are cast integral with the engine. Connecting rods are cast with side plates. All oil passages are cast integral with the engine.

### Wash Gear

A complete and separate wash gear system is placed on each side of the engine. The wash gear is built up of four cast iron parts, and five gear for the hull bearings, mounted on a tubular shaft. A cast iron

### General Dimensions

The following table gives the general dimensions of the engine. The dimensions are given in inches, and the weight is given in pounds.

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(3) That for commercial success speed is probably the most important factor.

(4) That for commercial success the speed needed depends very greatly on the magnitude of competing land routes. Between large centers connected by direct high speed airways, ground speeds of 100 mph are desirable, but for landing places between which the primary service is slow or interrupted by sea routes, lower speeds would be desired commercially.

(5) That, at present, stages of about 500 miles would be the normal ideal, but that it will be desirable from the commercial point of view that stages should be as long as possible.

(6) That it is desirable as far as possible to develop the existing facilities for night flying, especially for the emergency of war.

(7) That heavy loading is necessary for commercial success, but, more than that, involves a high landing speed, development of land and air brakes of necessity.

(8) That in view of certain disadvantages of high landing speed, efforts should be made to keep landing as low as possible consistently with overall rates of speed and to provide for aerodromes and landing places possessing the best possible facilities, and that it may well be hoped that future invention and improvements in design will enable a lower landing speed to be attained without sacrifice of flying speed.

#### Private Cost

It is particularly impossible to give any satisfactory estimate of running costs of either type of aircraft from existing data. General figures relating to cost must be considered as indications only, the weight of an airplane is a definitely fixed quantity, and the amount of commercial load depends on the length of journey.

#### Figures quoted as shown are

	Private cost per hour	Private cost per mile	Private cost per lb. of payload
Light aircraft	£100	£100	£100
Medium aircraft	£100	£100	£100
Heavy aircraft	£100	£100	£100

#### Air Routes Generally

In considering the planning and definition of particular air routes, certain general considerations arise. In the case of a commercial aerial service the route will generally begin or end at some large town or center of population, but in some cases may be unconnected with the needs of commercial traffic in a particular country and in accordance with the facilities of prevailing winds and landing facilities in the case either of long over-sea routes or sub-continental routes or of long passages over the sea.

In the two latter instances the necessity for a planned and defined route is infinitely reduced. For in the case of a light aircraft, a direct, or the preferred, facilities for a light aircraft are unimportant, and in the case of a flight from America to Europe prevailing winds will give a large part in fixing actual and estimated tracks. In the case of the Kingdom, or in any other in England, general and future military requirements will involve the creation of a large number of landing grounds, but these will be determined by the presence of suitable navigational stations in necessary for the sake of compass, speed, reliability and safety of navigation.

#### The Atlantic Route

As in the Atlantic route, Commander Perle pointed out in his report that for some time it was a direct route from London to Newfoundland and vice versa will be found unimportant. He suggested that the route possible between the Trans-Atlantic route in the general case, and for many years to come, would be to use the "great circle" route, suggesting that it might be possible to use the "great circle" route from London to New York, and from New York to New Zealand. The use of Newfoundland as a terminus presents great difficulty owing to certain fog on the banks around Newfoundland itself. The effect of this fog is to make a journey westward to Newfoundland liable to the danger and uncertainty involved

in having to come down to land through the fog. The same difficulty does not occur in the case of a direct route from London to New Zealand, as the fog is not so severe. It is suggested, however, that the route should be a comparatively short period but should be a direct route.

Commander Perle's conclusion is that, at any rate in the immediate future, it would be preferable to fix upon New York as the Western terminus of the Atlantic route. The distance from New York to London is roughly 3,000 miles, and Commander Perle suggests that the question of dividing this long distance into reasonable stages it should be necessary to design and arrange for "three stations," in the shape of long ships, of say, 300 ft. by 10 ft. with a clear upper deck of 400 ft. fitted with wireless and the necessary signaling apparatus. Such an arrangement would make possible the use of airplanes rather than airplanes.

While Commander Perle is a high authority, the Special Committee do not feel that they possess sufficient independent information to enable them to express a confident opinion with regard to his conclusions. For as these are based upon the prevalence of fog on the Newfoundland coast, Major Taylor is disposed to think that they are open to question. Major Taylor's impression, based upon his study of the subject, is that the fog prevailing off the Newfoundland coast is not so severe and is not so persistent for island. Any further evidence that could be obtained on this point would be valuable.

Here, again, the Committee can only recommend that a practical experiment should be conducted as early as may be possible, all available information as to the weather conditions should be collected and that may be in the possession of the Meteorological Office or of the Governments of the U. S. A., Canada, and Newfoundland having first been studied with a view to understanding the experience with the best chance of success.

This route would appear to be a particularly suitable one for an experiment with dirigibles as well as with airplanes, the distance to a direct line from the East Coast of Newfoundland to the West Coast of England being no more than could be accomplished in favorable weather by dirigibles already in existence.

#### Working of Aerial Routes

As to the working of aerial routes, several recommendations have been made.

Wing Captain Gifford has suggested that all main routes should be worked at intervals of five miles by a ship, 300 ft. in length and 10 ft. in breadth. If composed of ships or boats, the main route should be worked at intervals of five miles by a ship, 300 ft. in length and 10 ft. in breadth. If composed of ships or boats, the main route should be worked at intervals of five miles by a ship, 300 ft. in length and 10 ft. in breadth. If composed of ships or boats, the main route should be worked at intervals of five miles by a ship, 300 ft. in length and 10 ft. in breadth.

Commander Colonel O'Donnell, after considering the recommendations of Captain Gifford, suggested that main routes should be worked at intervals of five miles by a ship, 300 ft. in length and 10 ft. in breadth. If composed of ships or boats, the main route should be worked at intervals of five miles by a ship, 300 ft. in length and 10 ft. in breadth.

The suggestion which merits with the approval of the Special Committee, is that the route of a ship, station or ship should have their issues related upon them in letters large enough to be deciphered by the pilot of an aircraft. It will be of great advantage that these letters should be large enough to be deciphered by the pilot of an aircraft.

The Special Committee recognize that while it may seem the case for a military airship to find its way from one landward station to another, or to follow some convenient railway, one should not forget that the airship is a very slow and clumsy machine. It is suggested that the route of a ship, station or ship should have their issues related upon them in letters large enough to be deciphered by the pilot of an aircraft. It will be of great advantage that these letters should be large enough to be deciphered by the pilot of an aircraft.

## The Bijur Airplane Engine Starter

The Bijur airplane engine starter was designed at the request of the Bureau and of the Airplane Engineering Department of the Royal Corps for use particularly on airplanes. It is designed to start a cylinder of maximum weight and low speed consumption combined with a maximum of reliability.

engine crankshaft (Fig. 2) are removed and replaced by two long studs which project from the bottom of the starting motor housing.

Normally there is no connection between the starting motor and engine crankshaft. A gear ring is placed between the

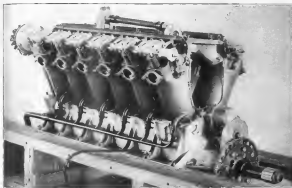


FIG. 1. ENGINE-DRIVEN STARTER WITH A POWER STARTER

power to break over a stiff engine. It was thought that the starting of these results would necessitate the starting down of the crankshaft to a very low speed, and it will be seen from the data given below, the desired results have been obtained without undue sacrifice of speed.

#### Characteristics

Weight of starting motor, 29.5 lb.  
Weight of gear ring, 18 lb.  
Cranking speed, 50 to 100 rpm (depending on condition and stiffness of engine).  
Cranking speed (revs.), 40 to 50 rpm.  
Torque available on engine crankshaft to break over a frozen engine, 5.68 lb. ft.

As will be noted from the accompanying illustrations, the starter consists of an electric motor, 4 in. in diameter, fitted with a clutch or reduction and a special form of the Bijur automatic power-lifting mechanism. This is similar in nature to the Bijur ship used on automobile starting apparatus, but not so varied and complicated by the special use. The motor is mounted directly on the propeller end of the Liberty engine without the use of intermediate bracket (Fig. 1).

In case the starter of the Liberty engine, two sets of the base of the old Liberty 1A, 1B, or 21 are removed and replaced by two extension studs supplied with the starter. Two pins on the starter end of the engine are removed by the original pins are put back on the extension end of the Liberty. The two bearing holes at the front propeller end of the

propeller hub flange and the propeller, and is held by the regular propeller hub bolts passing through holes in the gear. The pinion of the starting motor is attached to the flange of the propeller. The pinion of the starting motor is attached to the flange of the propeller. The pinion of the starting motor is attached to the flange of the propeller. The pinion of the starting motor is attached to the flange of the propeller.

The battery used is a special type made by the Willard Storage Battery Co. and designated as type C-20-20. This has two cells, rated at 25 ampere hours and weighs approximately 75 lb. The battery is such as to support an instant start-up in 10 to 15 seconds. Tests on the three-celled model show that it can start a 25 hp engine in 10 to 15 seconds. The battery is such as to support an instant start-up in 10 to 15 seconds. Tests on the three-celled model show that it can start a 25 hp engine in 10 to 15 seconds.

The propeller end of the engine was selected as the most convenient point of attachment for the starter. The use of a very simple and sturdy form of drive from the starting motor to the crankshaft, without the use of clutches or couplings. It also allows use of spare not available for other purposes, while it is also possible to drive such machines from the engine end of the engine.

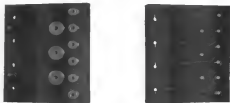






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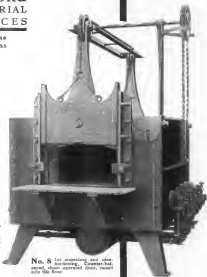
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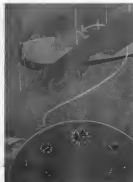
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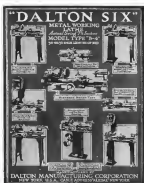
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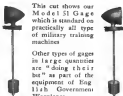


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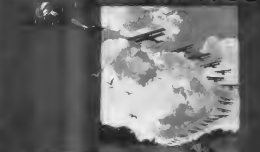
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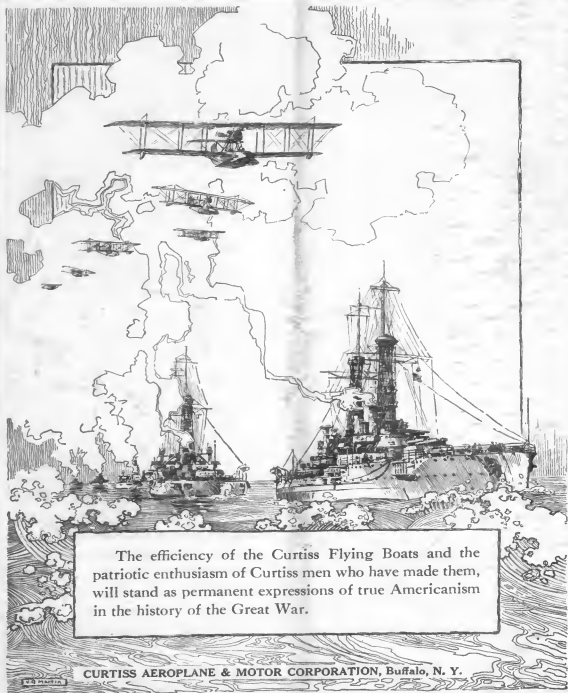
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